AD-A100 392 HUMAN ENGINEERING LAB ABERDEEN PROVING GROUND MD F/G 5/5
AN INVESTIGATION OF THE EFFECTS OF THE DH-132 HELMET SUSPENSION--ETC(U)
APR 81 R B RANDALL
UNCLASSIFIED HEL-TN-3-81 NL

1 OF 1
AD
A100392

END
DATE
FILMED
7-81
DTIC

Technical Note 3-81

AN INVESTIGATION OF THE EFFECTS OF THE DH-132 HELMET SUSPENSION SYSTEM UPON PERCEIVED HELMET WEIGHT UNDER STATIC CONDITIONS

R. Bradley Randall

April 1981
AMCMS Code 612716.H700011

U. S. ARMY HUMAN ENGINEERING LABORATORY
Aberdeen Proving Ground, Maryland

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER
Technical Note 3-81

2. GOVT ACCESSION NO.
AD-A100 392

3. ~~RECIPIENT'S CATALOG NUMBER~~
17 HEL-TN-3-81

4. ~~TITLE (and Subtitle)~~
AN INVESTIGATION OF THE EFFECTS OF THE DH-132 HELMET SUSPENSION SYSTEM UPON PERCEIVED HELMET WEIGHT UNDER STATIC CONDITIONS,

6

5. TYPE ~~OF REPORT & PERIOD COVERED~~
Final rept.

6. PERFORMING ORG. REPORT NUMBER

7. AUTHOR(s)
R. Bradley/Randall

8. CONTRACT OR GRANT NUMBER(s)

9. PERFORMING ORGANIZATION NAME AND ADDRESS
US Army Human Engineering Laboratory
Aberdeen Proving Ground, MD 21005

10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
AMCMS Code 612716.H700011

11. CONTROLLING OFFICE NAME AND ADDRESS

12. ~~REPORT~~ DATE
Apr[illegible] [illegible]81

13. NUMBER OF PAGES
10 11

14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)

15. SECURITY CLASS. ~~(of this report)~~
UNCLASSIFIED

15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)
Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)
Helmet Suspension System
DH-132 Helmet
CVC Helmet
Helmet Weight Differences
Human Factors Evaluation

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)
The effects of the Standard "A" DH-132 Combat Vehicle Crewmember (CVC) helmet suspension system upon perceived helmet weight were investigated. Twenty-three test participants were used in the experiment which evaluated their ability to judge helmet weight relative to a 62-ounce standard over a range of 42 through 82 ounces. A relatively narrow range of indecision--reference weight plus and minus 6-1/4 ounces--indicated that the CVC type of helmet suspension system made the wearer sensitive to relatively minor changes in helmet weight.

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

172850

AMCMS Code 612716.H700011 Technical Note 3-81

AN INVESTIGATION OF THE EFFECTS OF THE DH-132 HELMET SUSPENSION SYSTEM UPON PERCEIVED HELMET WEIGHT UNDER STATIC CONDITIONS

R. Bradley Randall

April 1981

APPROVED: JOHN D. WEISZ
Director
U.S. Army Human Engineering Laboratory

U. S. ARMY HUMAN ENGINEERING LABORATORY
Aberdeen Proving Ground, Maryland 21005

A

CONTENTS

AN INVESTIGATION OF THE EFFECTS OF THE DH-132 HELMET SUSPENSION SYSTEM UPON PERCEIVED HELMET WEIGHT UNDER STATIC CONDITIONS

INTRODUCTION

The US Army Human Engineering Laboratory (USAHEL) supports a long-range program of the US Army Natick Research and Development Laboratories to develop an improved Combat Vehicle Crewmember (CVC) helmet. This helmet will have ballistic and bump protection, a communications system, and will be compatible with vehicle-mounted optical and fire-control equipment. This is an iterative program (PRON BG-0-00113-01-BG-A) where the results of human factors engineering evaluations of prototype models and experiments performed by the US Army Human Engineering Laboratory are incorporated into prototypes for further testing. Ultimately, it is hoped that the helmet will represent an optimum compromise between protection, user acceptability, and utility. These categories need not be mutually exclusive, but in practice, improved ballistic protection is usually achieved with a concomitant increase in mass, and this influences user acceptance. A heavy helmet may receive better user ratings than a light one if the user feels that it provides substantially greater protection. Ultimately, a point will be reached when the user feels the helmet is too heavy; any further protection gains are no longer worth decreases in comfort. It is also likely that a helmet suspension system has limits beyond which it will be impossible to adequately control helmet retention and stability, resulting in lessened user-acceptance which may then result in reduced use.

One of the USAHEL's responsibilities in this program is to provide design guidance as to the maximum weight of the new helmet. The US Army Aeromedical Research Laboratory (USAARL) has furnished guidance as to the level of impact protection the helmet must provide, but recommends that helmet weight be determined by user preference[1] and that a maximum weight limit of 3.2 pounds be adhered to.

It may be possible to increase the mass (and ballistic protection level beyond the 3.2-pound limit without the user's awareness). By manipulating the shape, center of gravity location, and suspension/retention system, one could provide relatively greater protection in a helmet that perceptually is no heavier than the standard. This investigation will explore the effects of one suspension system type on the wearer's perceptions of helmet weight. Ideally, one would hope to discover a suspension system that was insensitive to gross changes in helmet weight: no matter how much

---

[1]Hundley, T.A. Impact protection requirements for future combat vehicle crewmen's helmets (USAARL LR-80-8-3-5). Fort Rucker, AL: US Army Aeromedical Research Laboratory, 1980.

the weight is increased, it feels the same to the wearer. Conversely, a less desirable system would readily enable the wearer to discriminate minor changes in weight. Certainly, there are limits outside of which even the best suspension system cannot mask incremental changes in weight, and it is necessary to define these limits for different types of suspension systems.

OBJECTIVE

To explore the effects of the standard DH-132 CVC helmet suspension system upon perceived helmet weight.

METHOD

Subjects

A total of 23 male soldiers served as test participants. These men were artillery crewmembers participating in a human factors evaluation of a proposed artillery helmet. They were all permanently stationed at Fort Sill, OK.

Apparatus

The Standard "A" DH-132 helmet is composed of a full-contact cloth and foam pad suspension system coupled with a removable hard outer shell. This helmet system permitted test participants to wear the liner while outer shell weights were manipulated. The shells could be removed and replaced in exactly the same position for each experimental trial with minimal or no readjustment of the liner/suspension system. Outer helmet shells were modified through the addition of lead weights and cloth covers--the latter prevented the test participants from getting visual cues as to the weight of the shells. The liner of the helmet weighed 30 ounces; the standard shell weighed 12 ounces. As there was no way that this 42-ounce total could be reduced, it became the lower bound of the weight range investigated. Jones, et. al.[2] previously evaluated a different helmet suspension system's effects upon perceived weight using increments of 8 ounces over a range of 16 to 88 ounces. As weight increments of 8 ounces were readily discriminable using the DH-132 helmet, it was decided to use 4-ounce increments. In order to keep the test procedure from becoming too lengthy or unwieldy, the upper

---

[2]Jones, R.D., Corona, B.M., Ellis, P.H., Randall, R.B., & Sheetz, H.A. Perception of symmetrically distributed weight on the head (Technical Note 4-72). Aberdeen Proving Ground, MD: US Army Human Engineering Laboratory, 1972.

bound of the weight range was set at 82 ounces. Thus, 11 different shells were prepared which ranged in weight from the standard 12 ounces to a maximum of 52 ounces, giving on-the-head total weights of 42 through 82 ounces in 4-ounce increments as shown in Table 1.

TABLE 1

CVC Helmet Weights

Shell Number	Shell Weight (Ounces)	Total Weight (Ounces)
1	12	42
2	16	46
3	20	50
4	24	54
5	28	58
6 (reference)[a]	32	62
7	36	66
8	40	70
9	44	74
10	48	78
11	52	82

[a]Helmet shell number 6 became the *middle-of-the-range* reference weight (62 ounces) with five heavier experimental helmet shells and five that were lighter.

Procedure

A psychophysical testing method--Method of Constant Stimuli--was used as the test procedure. In this procedure the subject was presented with an experimental and a reference helmet on each trial, and asked whether the experimental helmet was heavier, lighter, or equal in weight to the reference helmet. The experimenter sat behind and placed the helmet shells on the test participant's (TP) head. The TP was not permitted to handle the shells before or during the evaluation. In order to control presentation errors which result from this experimental technique, the presentation order was randomized. In addition, the reference helmet was presented first in half of the trials, and second in the remaining half, in an ABBA scheme. Table 2 shows the presentation order followed for all trials.

TABLE 2

Helmet Shell Presentation Order[a]

Reference 1st	Reference 2nd		Reference 1st
4	10	7	4
6	5	9	3
9	9	2	11
8	11	3	1
7	7	5	2
1	2	10	7
11	1	6	5
5	6	1	6
10	3	11	8
2	8	4	10
3	4	8	9

[a]In this procedure each experimental helmet shell/reference helmet shell comparison was made four times. The TP's were given rest opportunities after every 11 trials.

RESULTS

Figure 1 shows the results plotted as the percentage of correct "heavier than" judgements versus helmet weight in ounces. The M1 helmet data from the Jones[2] study are also shown. The Just Noticeable Difference (JND) for the upper weight threshold (responses of "heavier" 75 percent of the time) was calculated to be 68.5 ounces, while the lower threshold (responses of "heavier" 25 percent of the time) was 56 ounces. The Point of Subjective Equality (PSE) was 62.25 ounces.

DISCUSSION

The results of this evaluation indicate that the TP's could not accurately judge weight on the head within 4 ounces. A range of indecision (Figure 2) of 12-1/2 ounces was found around the 62-ounce reference weight (on the average, the TP's were unable to differentiate between the standard helmet and helmets weighing as little as 56 ounces, or as much as 68.5 ounces).

Jones[2] tested both Infantry and Ordnance soldiers. They found that the Ordnance soldiers were more accurate in their weight judgements than the Infantry group, who were more accustomed to wearing the M1 helmet. As the artillery crewmen were unaccustomed to wearing CVC helmets, it seems appropriate to compare this data with that of the Ordnance soldier group.

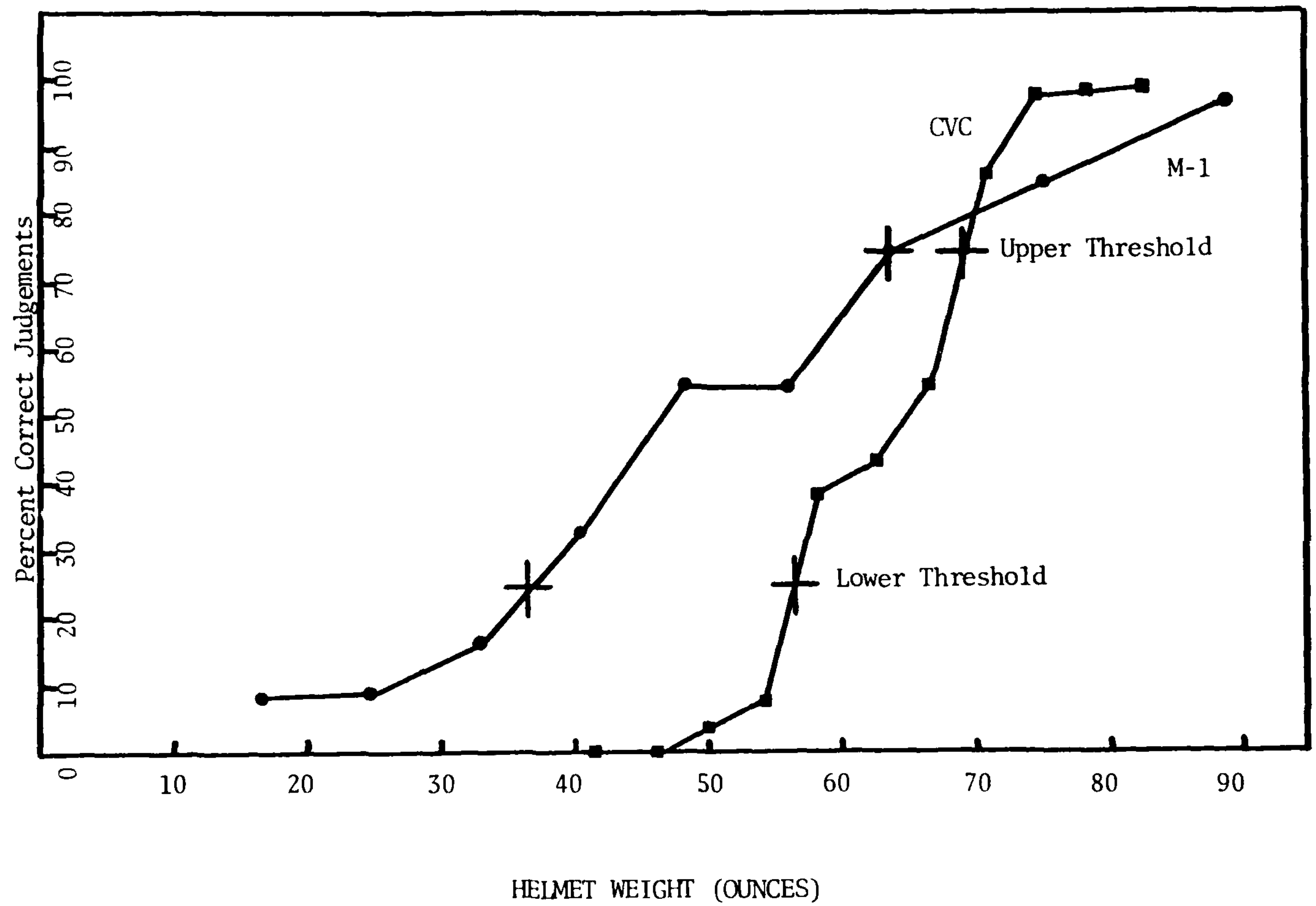

Figure 1. Helmet weight versus percent correct weight judgements.

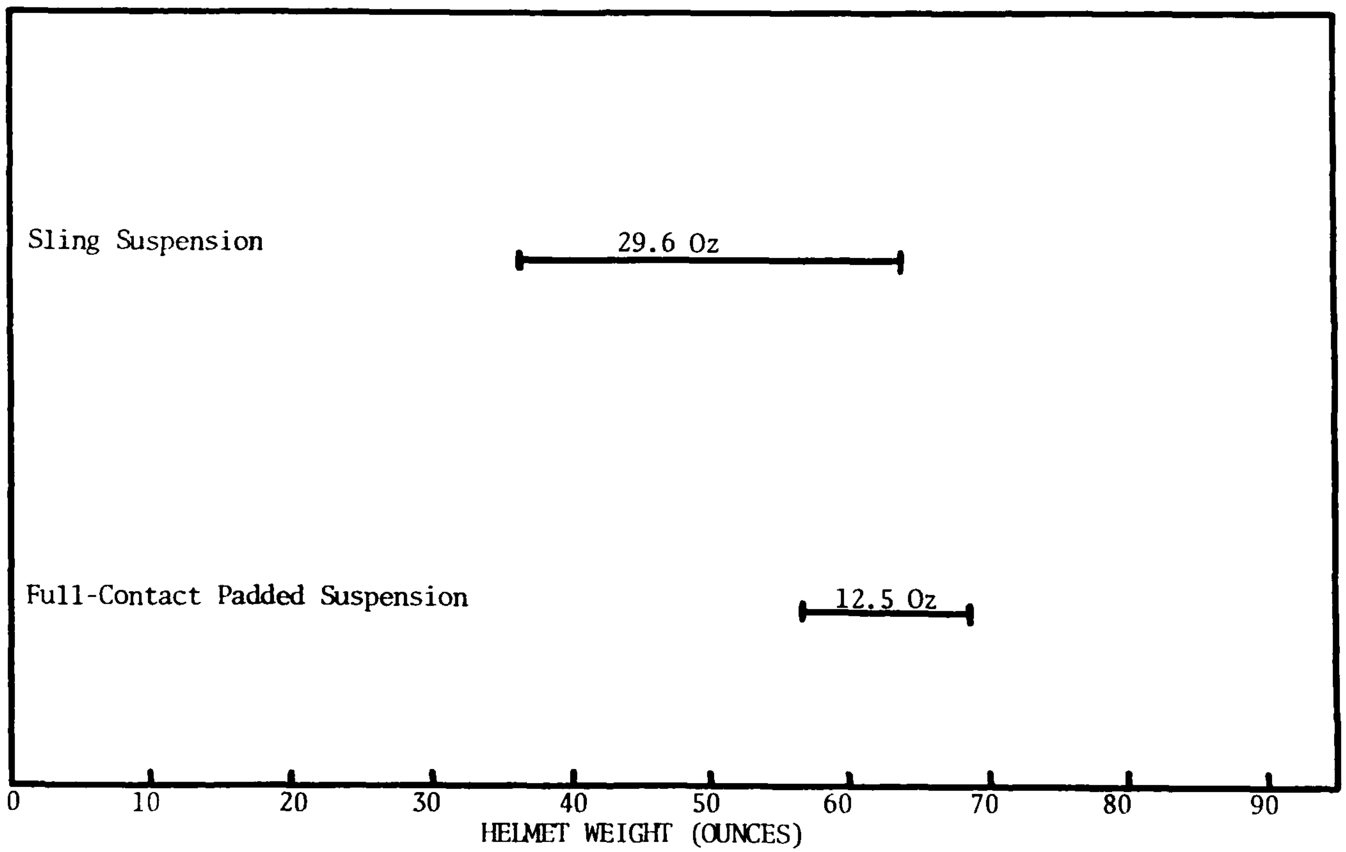

Figure 2. Range of indecision by suspension system.

The range of indecision for the Ordnance group was 29.6 ounces around a reference weight of 48 ounces (on the average, the Ordnance soldiers were unable to differentiate between the standard helmet and helmets weighing as little as 33.2 ounces, or as much as 62.8 ounces). While this relatively large range of indecision (more than twice the CVC range) may have been partly due to a lower reference weight, it was more likely strongly influenced by the type of suspension system used. Their suspension system was a Riddell sling-type using a circumferential sweatband with across-the-head straps to a crown pad. An evaluation of two different CVC helmet suspension systems by Randall[3] in 1980 revealed that a CVC helmet using a similar system was perceived as being lighter, better balanced, more stable, and more comfortable than a lighter helmet having full-padded suspension. Thus, a CVC helmet designer should be able to use a sling system to good advantage to build a heavier helmet which will provide relatively greater protection, and yet be perceived by the wearer as equivalent to a lighter less-protective helmet which uses the padded full-contact suspension.

CONCLUSION

The full-contact padded suspension system used in the DH-132 CVC helmet permitted the test participants to detect relatively minor changes in helmet weight. The range of indecision was small, only 12.5 ounces around the reference weight, which indicates that this suspension system would be a poor candidate for use in future helmet development programs.

RECOMMENDATION

The full-contact padded suspension system should not be used in future CVC helmets. Other systems, such as the Riddell system, offer advantages which may be exploited by helmet designers to give increased protection with lower perceived weight than current systems provide.

---

[3]Randall, R.B. Human engineering evaluation of the CVC helmet suspension (Letter, DRXHE-IS). Aberdeen Proving Ground, MD: US Army Human Engineering Laboratory, 6 March 1980.

DATE
FILMED

8